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Updates to Wind Intermittency Algorithms for AEO2004

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Renewable Energy Modeler's Summit

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Overview

- Background
- Capacity Credits
- Surplus Curtailment
- Other updates

Background

- Capacity credit algorithm updated for AEO2003
  - Was fixed credit with low penetration limit
  - AEO2003 had declining credit with higher limit
- AEO2003 decline function was exogenously estimated
- AEO2003 limit was based on potential cost of surplus curtailments

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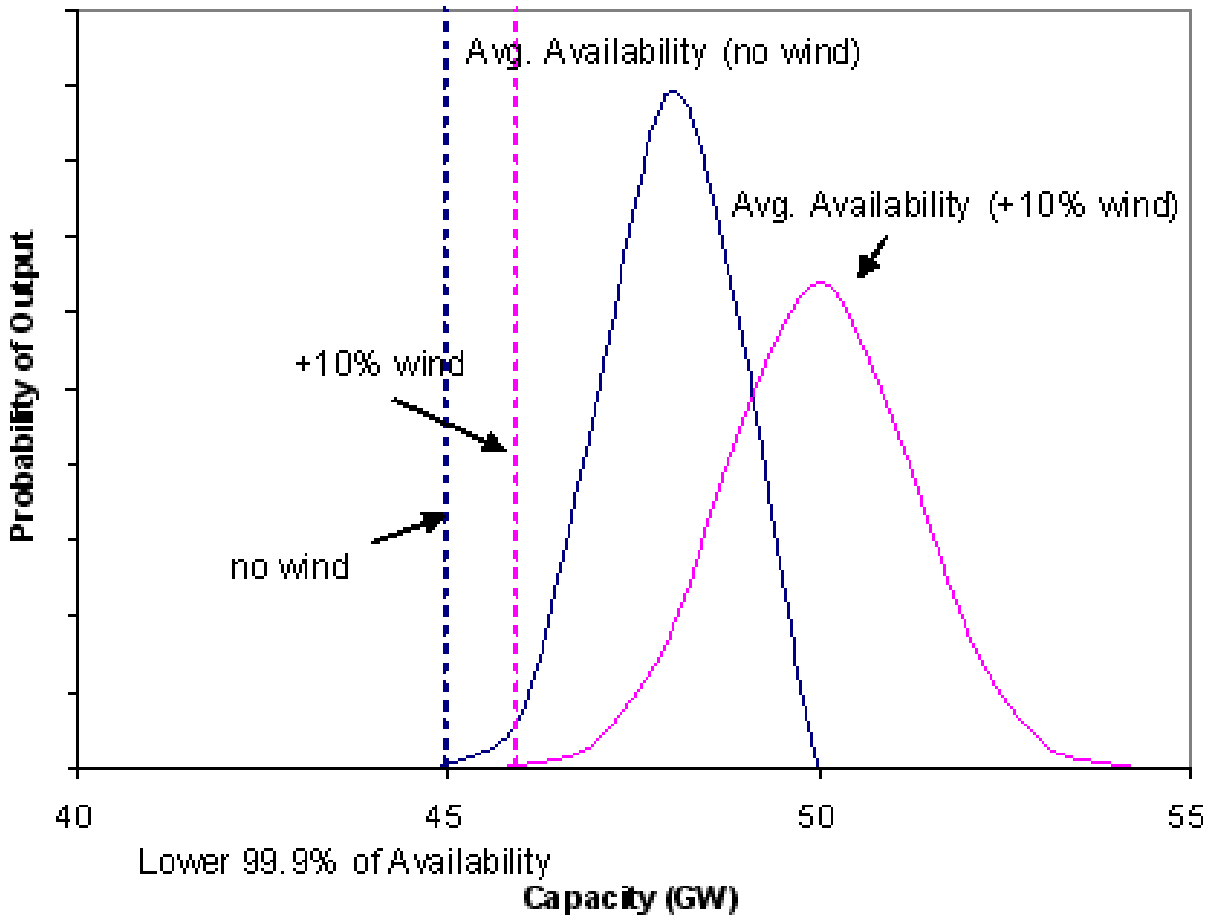
Capacity Credit Algorithm

- AEO2004 has improved function for estimating capacity credit decline
  - Endogenously determined
  - Based on reliability characteristics of installed capacity and assumed regional wind variation
- Statistical/Probabilistic approach used
  - Estimate standard deviation of conventional plant availability and wind plant availability

Capacity Credit for Wind



- Fundamental Calculation:
  - Determine of “5-nines” load carrying capacity with and without wind
  - Capacity credit is difference between LCC over total wind capacity

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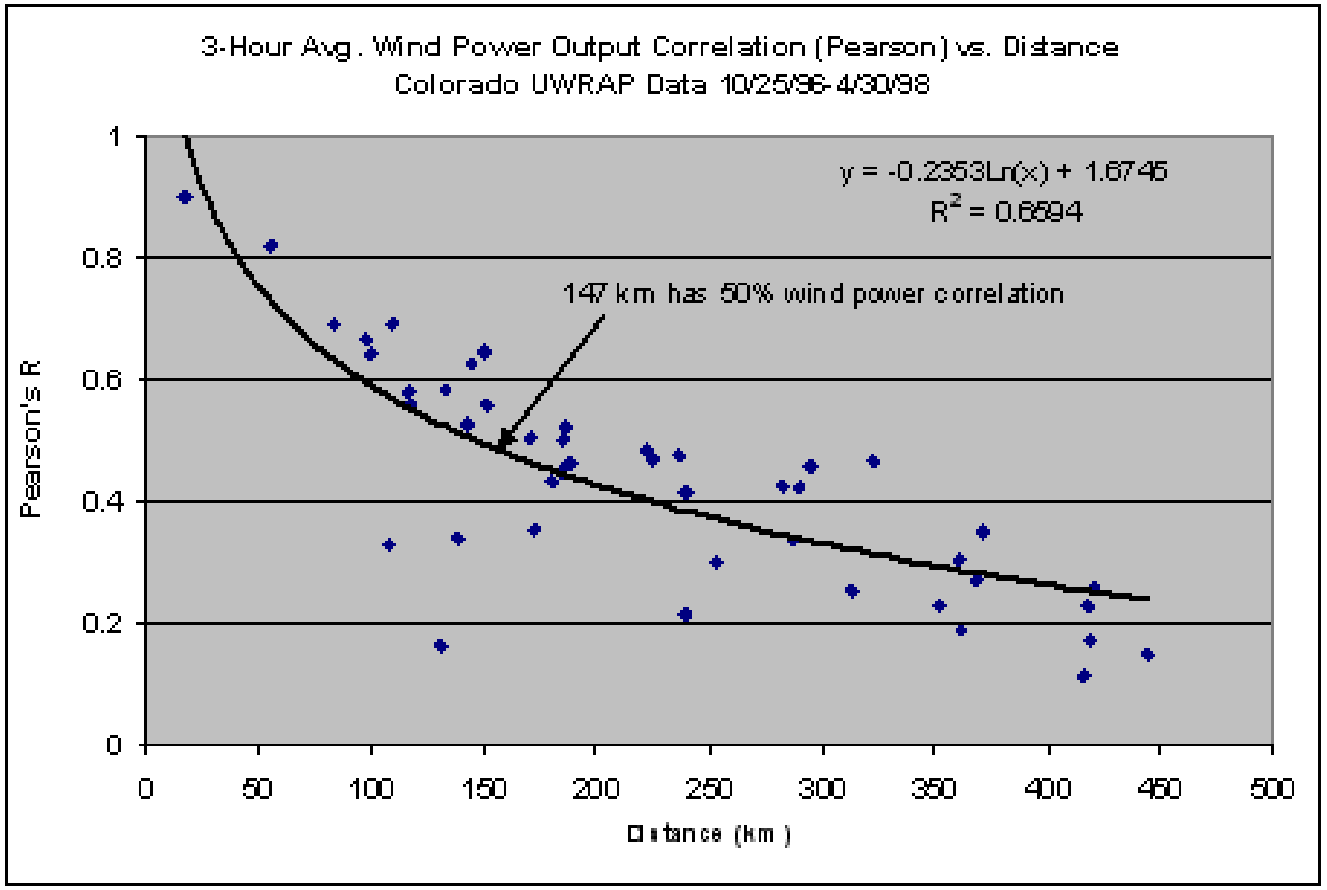
Accounting for Reliability

- Conventional plant outages are assumed to be uncorrelated with each other
- Wind output variance modeled on “typical” turbine in an average, Class 6 wind regime
  - Output statistics scaled to 50 MW plant size
- Wind availability is correlated as a function of distance between wind plants
  - Neighboring plants would see same resource at same time
  - Distant plants would be less correlated
  - Time frame of interest is hourly/daily

Data on Wind Dispersion

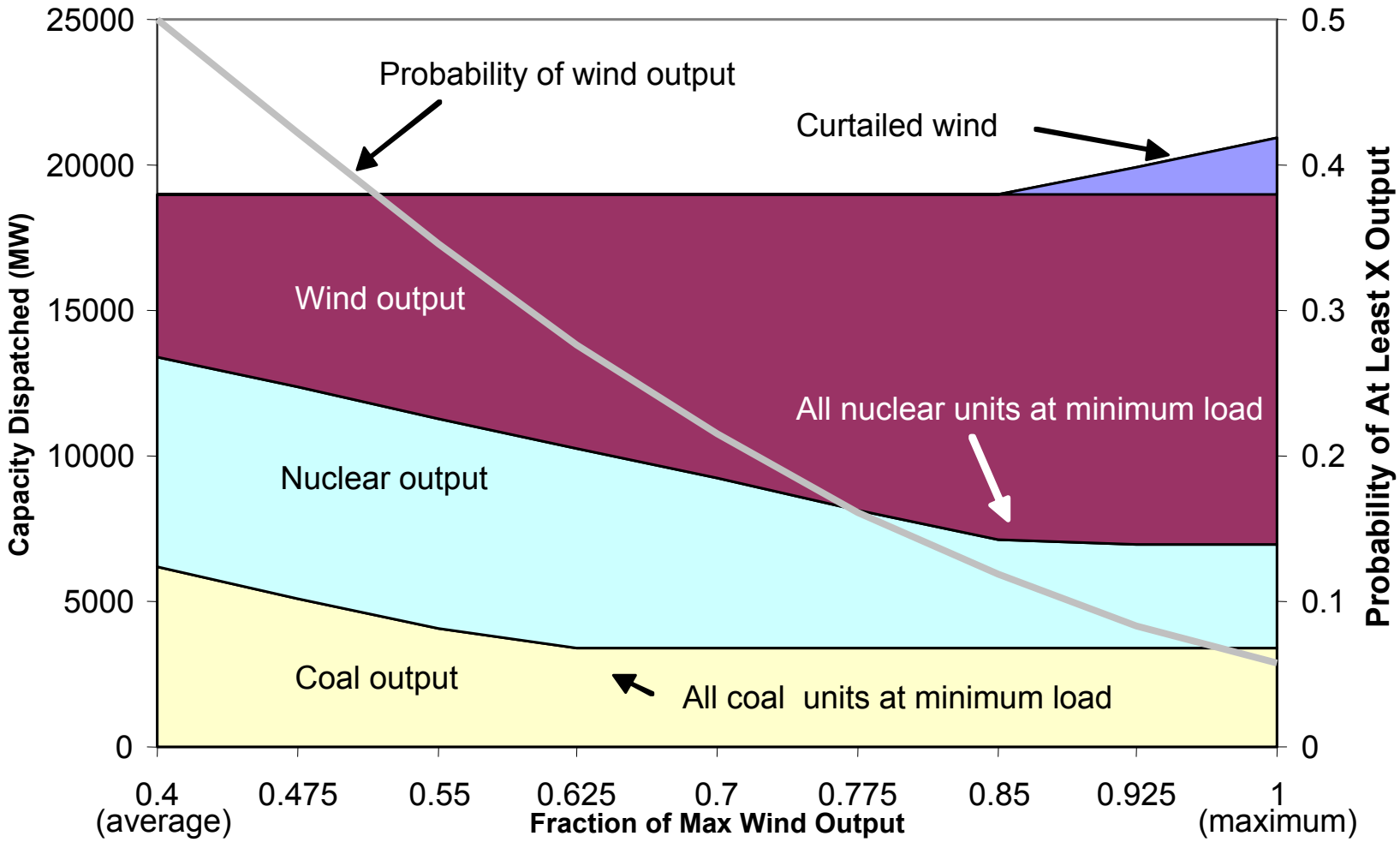


- Uses hourly wind data collected for resource assessment
- Final correlation factor based on regional size

Surplus Wind Curtailment

- Accounts for system balancing during low-load periods with high wind penetration
  - Occasional high-wind conditions may cause excess generation on system, backing-off “baseload” units
- Long restart-time units (primarily coal and nuclear) will likely not be allowed to run below minimum operating levels
  - Wind has minimal operating cost to curtail
  - Cost of wind curtailment will be reduced utilization of high-cost capital

How Curtailment Works in NEMS



- Assumes max. coal turn-down is 3:1, max. nuclear turn-down is 2:1, all other units may be shut-down

Curtailment Implementation

- Surplus wind energy in each load period is subtracted from period total and capacity factor is recalculated for load period
  - New annual average capacity factor is recalculated as weighted average of all load periods
- Wind variability and dispersion statistics are same as used in capacity credit calculations

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Intermittency Summary

- Direct accounting for reliability and curtailment raises confidence that key intermittency costs are accounted for up to 40% wind penetration
- Algorithms estimate current system state
  - Large capacity increments will diverge significantly from model parameters
  - System assumed to need time to adjust to new operating regime with high penetration
  - Intermittent penetration limit increases by 5 percentage points per year from 20% to 40%

Current Projects

- Long-term cost adjustment factors
  - Frances will discuss improvements to algorithm
  - Jim will discuss study to re-evaluate data
- Costs
  - Currently reviewing Form 412 data
  - Potentially a good source of real-world project cost data
  - Response rate was poor among wind industry
  - Form was designed for conventional plants
  - Working with CNEAF to improve data quality before data can be reliably analyzed
- Resource Characteristics
  - Get better data on regional wind dispersion
  - Re-evaluate data on load-period output of wind
    - Get better match to refined capacity credit calculation
    - Account for change in NERC regional boundaries